Investor Group on Climate Change

# Potential Earnings Impacts from Climate Change

## Construction Materials

This project is a collaboration between the Investor Group on Climate Change, Merrill Lynch and Monash Sustainability Enterprises, with funding assistance from the Australian Government Department of the Environment and Water Resources.

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Note: These reports were researched and written before the Australian Government's commitment to an Australian Emissions Trading Scheme and before any details of the scheme were available. Readers can find more information on policy regarding the Australian Emissions Trading Scheme at http://www.pmc.gov.au/climate_change/#emissions

# Executive Summary

- This report explores the exposure of the Australian construction materials sector of the S&P/ASX200 to climate change risk; focussing particularly on **carbon price risk**. The report discusses the construction materials sector as a whole, with analysis focusing on the cement sector.
- Production of construction materials involves significant greenhouse gas emissions, creating exposure to a price for carbon. **Cement production alone contributes around 3.8% of total global greenhouse gas emissions.**
- Modelling indicates that the cost to the Australian construction materials sector of a price on carbon varies considerably depending on the design of the emissions trading scheme. The key design features influencing this range are the sources of emissions covered by the scheme and the method used to allocate permits.
- Four different scenarios have been modelled to help determine possible impacts on the sector. Depending on the permit price and other key design features, a carbon pricing scheme including all greenhouse gas emissions from the cement industry from facilities in Australia, including emissions arising directly from operations as well as indirectly from electricity use, may impact the industry by between:
  - A reduction of 1% in mid-cycle net profit margins (reducing from 20% to 19.8%) at a carbon price of $5 per tonne $CO_2$-e and 90% free allocation of permits; to
  - A reduction of 79% in low-cycle net profit margins (reducing from 16% to 3.4%) at a carbon price of $25 per tonne $CO_2$-e and full auctioning of permits.
- These impacts represent the cost of carbon before considering cost pass through or emission reduction action, which both have the potential to reduce the ultimate impact experienced by the cement industry.
- The key design features influencing this range are the emissions covered by the scheme and the method used to allocate permits. In the short term it is envisaged that a large proportion of permits will be allocated free to liable parties, resulting in impacts at the lower end of the range.
- The estimated cost of carbon relates only to cement production in Australia, thus it represents only a portion of the total exposure for companies in the construction materials sector of the S&P/ASX200.
- **The cost to the Australian construction materials sector from an emissions trading scheme will not be spread equally across companies.** Exposure will vary significantly depending on the production technologies used as well as the product mix as these influence both emissions intensity and mitigation opportunities.
- To minimise the exposure to carbon price risk, regardless of the design of the potential emissions trading scheme, companies in the construction material sector should focus on emissions reduction initiatives. For the cement industry, key abatement opportunities relate to continued increases in the use of supplementary cementitious material and switching to less greenhouse intensive fuels.
- Emissions abatement may also be a revenue generation opportunity, as reductions in excess of any mandatory requirements may be able to be traded as carbon credits.
- **Physical damage** to infrastructure and disruption to operations in the construction materials sector from climate change is a potential risk but difficult to quantify.
- Building regulations designed to reduce energy consumption of buildings may also lead to changes in demand for specific construction materials and provide opportunities for product innovation for companies in the sector.

# Contents

# 1. The Construction Materials Sector's Contribution to Climate Change

The manufacture of construction materials such as concrete and concrete products, brick, aluminium, insulation and plasterboard, results in significant greenhouse gas emissions. Cement production alone accounts for around 3.8% of total global greenhouse gas emissions (see Chart 1).[i]

Construction materials, as an input into building design, also influence the amount of greenhouse gas emissions from residential and commercial buildings, which together are responsible for a further 15.3% of global emissions.

Globally, cement demand and production are expected to increase significantly over coming decades, leading to a large growth in emissions.

In Australia, manufacture of cement, lime, plaster and concrete, together contributed 7.7 million tonnes of carbon dioxide equivalent emissions (mt $CO_2$-e) or 1.4% of total net Australian emissions in 2004.[ii] The single most significant source of emissions from construction materials is the production of cement clinker, which contributed 3.5 mt $CO_2$-e or around 0.6% of total net Australian emissions in 2004.[iii]

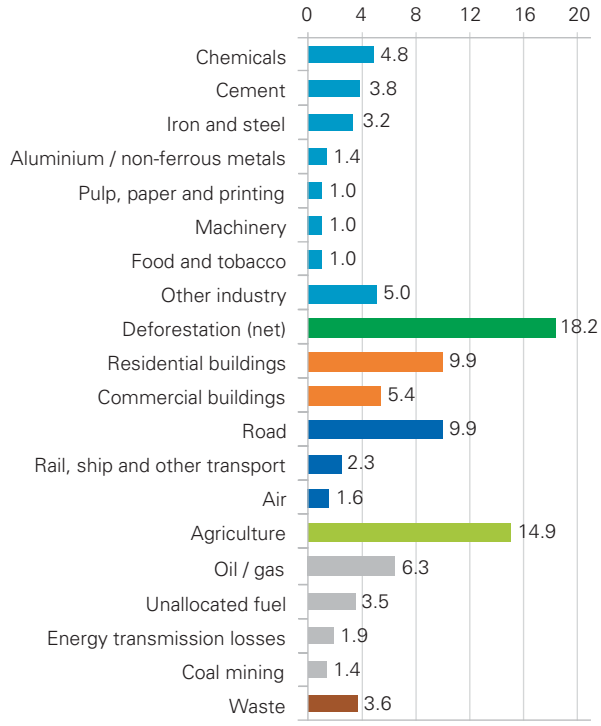
Greenhouse gas emissions arise throughout the construction materials supply chain. Different construction materials differ both in the sources and total quantity of greenhouse gas emissions associated with their manufacture.

For construction materials generally, the majority of emissions are generated in the manufacturing phase and are predominantly carbon dioxide, with only small amounts (less than 1%) of other greenhouse gases.[iv]

Throughout this report, the emissions sources have been grouped into the following three categories based on *The Greenhouse Gas Protocol* [v]– the leading standard globally on corporate greenhouse accounting and reporting:

- Direct – emissions from sources owned or controlled by the company / asset (includes both combustion and process emissions);
- Indirect electricity – emissions associated with the production of electricity consumed;
- Other indirect – emissions that are a consequence of the activities of the company, but arise from sources owned by another (suppliers or customers).

**Chart 1: Global Emissions by End Use/Activity**




## 1.1 Greenhouse Gas Emissions Intensity of Common Building Materials

In order to assess the impact of a carbon pricing scheme it is necessary to understand the greenhouse gas emissions intensity of different construction materials.

The differences in greenhouse gas emissions between construction materials and between manufacturers of the same construction materials is largely caused by:

- Energy intensity of manufacture;
- Greenhouse gas emissions intensity of the energy sources;
- Other emissions sources: process and transport emissions; and
- How the product is used, in particular, the different quantities of each substitute product required.

Each of these issues is discussed below and summarised in Table 3 Summary of Energy and Emissions Profile of Common Building Materials.

# 1. The Construction Materials Sector's Contribution to Climate Change

### 1.1.1 Energy Intensity of Manufacture

Energy intensity of manufacture (or Process Energy Requirements, PER) is often expressed on a 'per tonne of material' basis (as in section 1.1.4 below).

However, in order to be comparable, PER values must take into account the different quantities of materials required for a particular application. For example, the weight of clay bricks required to clad a wall would be far greater than the weight of fibre cement for the same application. In this way, a comparison of the energy intensity of different materials should consider both the PER per tonne and the tonnage required of each material for the application being considered.

Further, construction materials are not used in isolation, but in combination, as part of a building system. Thus, it is the PER of the building system that is the most appropriate basis of comparison.

**Table 1: Process Energy Requirements of Domestic Wall Systems**[vi]

| Building System | PER ($MJ/m^2$) |
|---|---|
| Fibre cement weatherboard, timber framed, plasterboard lining | 169 |
| Timber weatherboard, timber framed, plasterboard lining | 188 |
| Steel clad wall, timber framed, plasterboard lining | 336 |
| Cement stabilised rammed earth | 376 |
| Aluminium weatherboard, timber framed, plasterboard lining | 403 |
| Cavity concrete block wall, plasterboard lining | 511 |
| Clay brick veneer, timber framed, plasterboard lining | 561 |
| Cavity (double) clay brick, plasterboard lining | 906 |

Example PER values for domestic wall systems constructed with different materials are presented in Table 1 (in megajoules per square metre, $MJ/m^2$). The table shows that to clad one square meter of wall, use of heavy materials, such as brick, results in far higher PER values than use of lighter weight materials, such as timber or fibre cement.

PER values vary significantly from study to study, depending on estimation method and assumptions, and may have high errors associated with estimates depending on the method used (up to ±50%).[vii] As such, care should be used in interpreting values and in comparing values from different studies.

### 1.1.2 Emissions Intensity of Energy Sources

Table 2 shows the greenhouse gas emissions intensity of common energy sources. The use of electricity is significantly more emissions intensive per gigajoule of energy than direct combustion of natural gas or coal on-site. However, there is often limited substitutability between different energy sources.

**Table 2: Emissions Intensity of Common Energy Sources** (Kg $CO_2$-e per gigajoule, 2004) [viii]

| | Vic | Qld | WA | SA | NSW | Tas |
|---|---|---|---|---|---|---|
| Indirect – Electricity | 407 | 321 | 276 | 280 | 274 | 8.7 |
| Combustion – Natural gas | 63.4 | 64.2 | 60.0 | 71.2 | 68.0 | n/a |
| Combustion – Coal (unwashed) | 94.6 | 94.9 | n/a | n/a | 97.0 | n/a |

For most construction materials, other than cement and cement-products, indirect electricity emissions is the largest source of greenhouse gas emissions and for some manufacturers represents the bulk of total emissions.

# 1. The Construction Materials Sector's Contribution to Climate Change

In Australia, average greenhouse gas emissions intensity of the electricity supply, varies significantly from state to state (as shown in Table 2).[ix] Emissions intensity varies from 8.7 kg $CO_2$-e per gigajoule (GJ) in Tasmania where electricity generation is predominantly hydro to 407 Kg $CO_2$-e per GJ in Victoria where brown coal is the dominant fuel for electricity generation. Thus, the location of production facilities can influence the emissions intensity of materials.

Greenhouse gas emissions from the manufacture of cement are a major source of emissions for cement-based products, such as concrete and fibre cement. For example, emissions associated with cement constitute a maximum of around 37% of total life-cycle emissions for fibre cement products, compared to a maximum of around 22% of greenhouse emissions from electricity used to produce the fibre cement.[x]

### 1.1.3 Other Emission Sources: Process and Transport Emissions

Direct process emissions are those arising from on-site chemical processes other than combustion in the manufacturing process. For cement, more than 50% of greenhouse gas emissions are process emissions that arise as part of 'clinkering' – the chemical process of converting limestone ($CaCO_3$) to calcium oxide (CaO), the primary precursor to cement.

Use of fuels for transporting raw materials and finished goods is a further source of emissions. Transport emissions are generally very small compared to other emission sources. For example, emissions generated in the transport of cement are estimated to contribute less than 1% of total supply chain emissions.[xi]

### 1.1.4 Summary of Energy and Emissions Profile of Common Building Materials

The energy and greenhouse profile of common construction materials is summarised in Table 3 including:

- Energy intensity of manufacture (PER);
- Typical energy sources and greenhouse gas emissions intensity of the energy sources;
- Other emission sources: process and transport emission; and
- An assessment of the overall greenhouse intensity of the product, taking into account how the product is used, in particular, the different quantities of each substitute product typically required.

Indicative values for greenhouse gas emissions (tonnes of carbon dioxide, $tCO_2$) per tonne of material are presented where available.

# 1. The Construction Materials Sector's Contribution to Climate Change

**Table 3: Summary of Energy and Greenhouse Gas Emissions Profile of Common Building Materials[xii]**

| | Energy intensity (PER) | | Emissions from energy use | | | Other emission sources | | Overall emissions intensity of final product |
|---|---|---|---|---|---|---|---|---|
| | GJ per tonne | GJ per m3 | Major energy sources [1, 2] | Emissions intensity energy source | Overall emissions from energy[3] (estimates presented as $tCO_2$ per tonne material) | Process emissions | Other indirect emissions | |
| **Steel general (blast furnace production)** | 32 | 251.2 | Coal (majority) Natural gas Electricity | High | Very High 2.55 | Low | Low | High |
| **Cement** | 3.5[xiii] | 6.8 | Coal (majority) Natural gas Electricity | High | High 0.35[xiv] | High 0.420[xv] | Low | High |
| **Ready-mix concrete (30 MPa)** | 1.3 | 3.2 | Electricity | High | Medium | – | Medium – associated with cement input | Medium |
| **Clay brick** | 3 | 6.2 | Natural gas (majority) Electricity | Medium | Medium 0.20[xvii] | – | Low | Medium – final product is heavy & used in large volumes |
| **Fibre cement** | 9.5 | 13.6 | Electricity | High | Low | – | Medium – associated with cement input | Medium – final products are of low density and thin (average 7.5mm) |
| **Plasterboard** | 6.1 | 5.9 | Electricity | High | Low | – | Low | Low – final products are low density and thin |
| **Timber (softwood kiln dried rough sawn)** | 1.6 | 0.9 | Electricity | High | Low | – | Low | Low |
| **Fibreglass insulation** | 30.3 | 1.0 | Electricity | High | Low | – | Low | Low – final products have low densities |

[1] Coal and natural gas are listed where these are used on site (and result in direct emissions).

[2] The emissions intensity of electricity consumption will depend on the fuel used to generate the electricity, which is here assumed to be predominantly coal.

[3] Energy intensity (GJ per tonne) by Emissions intensity energy source (column 1 by column 4)

# 2. Overview of Australian Construction Materials Sector

The Australian construction materials sector is generally described as being consolidated, vertically integrated and reasonably mature.

For many of the major construction materials a few suppliers dominate, with the top two or three players accounting for 75 -100% of the market.

Vertical integration serves to tighten the overall structure of the market. For example, the key metro aggregate deposits are generally controlled by Boral, Rinker (recently acquired by Mexican company Cemex) and Hanson (recently acquired by German domiciled Heidelberg Cement).[xviii] These three companies also control two thirds of both the cement and ready-mix concrete markets. Fragmented products and/or markets are in the minority. However, where they do exist (for example, softwood structural timber or Melbourne aggregates) they tend to suffer from much more volatile and cyclical pricing.

**Table 4: Companies in the Construction Materials Sector of the S&P/ASX200**

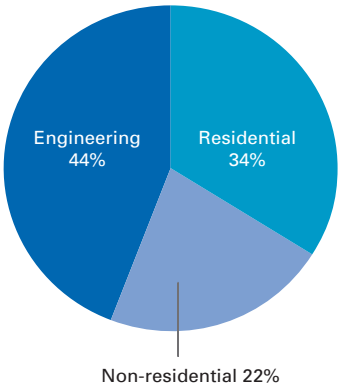
| Adelaide Brighton | Boral | CSR | James Hardie |
|---|---|---|---|
| ABC | BLD | CSR | JHX |
| **Market Cap (AUD) as at 3 August 2007** | | | |
| 1.8 billion | 4.8 billion | 2.9 billion | 3.5 billion |
| **Product Mix** | | | |
| • Aggregates<br>• Cement<br>• Concrete<br>• Concrete products<br>• Lime | • Aggregates<br>• Asphalt<br>• Cement<br>• Ready mix concrete<br>• Concrete products<br>• Clay bricks, pavers and roof tiles<br>• Timber<br>• Plasterboard | • Clay brick, pavers and roof tiles<br>• Fibre cement products<br>• Glass<br>• Plasterboard<br>• Insulation<br>• Sugar<br>• Aluminium (25% interest)<br>• Property development | • Fibre cement products |
| **Countries of Operation** | | | |
| • Australia | • Australia<br>• USA<br>• Asia | • Australia<br>• New Zealand<br>• Asia | • USA<br>• Australia<br>• New Zealand<br>• Philippines<br>• Europe |
| **Earnings by segment (A$ most recent year reported)** | | | |
| EBITDA FYO6 AUD:<br>• Construction & Mining Materials $198m<br>• Building Products $13m | EBITDA FYO6 AUD:<br>• Construction Materials $410m<br>• Building Products $162m<br>• USA $219m<br>• Asia $30m<br>• Other $11m | EBITDA FYO7 AUD:<br>• Building Products $129m<br>• Aluminium $172m<br>• Sugar $178m<br>• Property $70m | EBITDA FYO7 AUD:<br>• USA $523m<br>• Asia Pacific $65m<br>• Other -$8m |

# 2. Overview of Australian Construction Materials Sector

The construction materials market is split into three key segments:

- Residential construction;
- Non-residential (commercial) construction; and
- Engineering (predominantly roads).

**Chart 2: Total Australian Construction Spend (year to March 2007) by Market Segment (AUD)**




As shown in Chart 2, residential and non-residential construction constitute the majority of total construction spend (34% and 22% respectively), while engineering represents 44%.

For companies within the construction materials sector of the S&P/ASX200, based on forecast earnings for 2007:

- Earnings from Australian residential construction ranges from 5% to 40% of group EBITDA; and
- Earnings from US residential construction ranges from 0% to 80% of EBITDA.

## 2.1 Sector Greenhouse Gas Intensity of Earnings

Greenhouse intensity of earnings is estimated as kilograms of carbon dioxide equivalent emissions per dollar of earnings (kg $CO_2$-e per $ EBITDA). Simply, this is a measure of the amount of greenhouse gases emitted for each dollar earned. The greenhouse gas intensity of earnings provides a broad indication of exposure to carbon price risk.

In Chart 3, an example diversified construction materials company and an example cement producer are shown compared to other examples drawn from across the S&P/ASX200. Further information on the estimation approach is included in Appendix One: Methodology Notes.

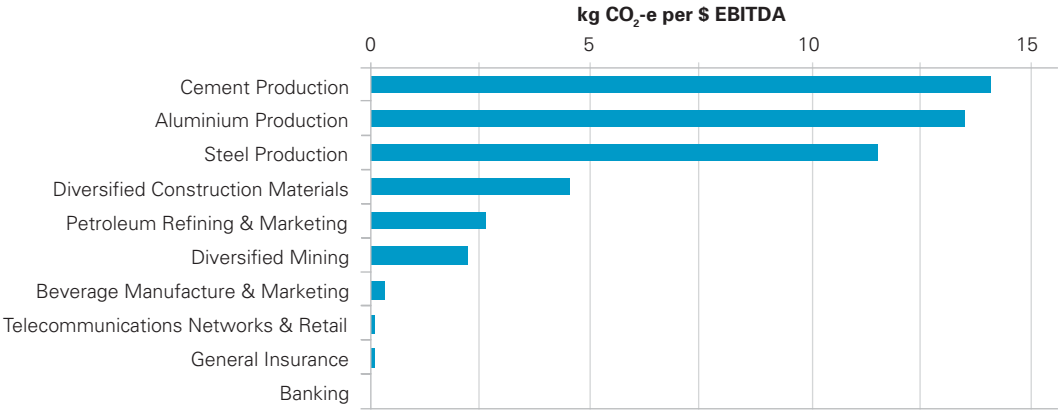
For companies in the construction materials sector of the S&P/ASX200 it is estimated that:

- Two out of the four companies have greenhouse intensity of earnings in the range of 4-8 kg $CO_2$-e per $ EBITDA – considered to be a medium intensity considering the range of values across the S&P/ASX200;
- One company has very high intensity (>12 kg $CO_2$-e per $ EBITDA); and
- One has low intensity (1-4 kg $CO_2$-e per $ EBITDA).

For construction materials, greenhouse gas intensity at the company level is driven by the product mix. Greenhouse gas intensity tends to be lower where:

- A larger proportion of products are less greenhouse intensive per tonne;
- End products are light weight;
- There is greater value adding to products; and/or
- There is a greater diversity in the product mix.

**Chart 3: Greenhouse Intensity of Earnings across the S&P/ASX 200 (estimated)**



# 3. Impact of a Carbon Price on the Construction Materials Sector

The financial impact of a carbon price on the Australian Construction Materials Sector will vary depending on the details of design and implementation of the pricing scheme.

Emissions trading schemes fall into two broad categories:

- Cap and trade; and
- Baseline and credit.

Cap and trade schemes involve:

- Setting an emissions 'cap' – the maximum amount of greenhouse gas emissions allowable in a given period. The difference between the cap and 'business as usual' emissions is the targeted reduction in emissions. It is common for carbon trading proposals to involve modest reduction targets initially, with progressively more stringent targets over time.
- Creating tradeable permits ('carbon credits') for the allowable emissions, i.e. a right to emit. Typically a permit will be for one tonne of carbon dioxide equivalent greenhouse gas emissions (1 $tCO_2$-e).
- Allocating tradeable permits to affected parties (including those emitting greenhouse gases).

Liable parties are required to surrender sufficient tradeable permits at the end of each period to cover all of their actual emissions. Liable parties who are able to reduce their emissions below the level for which they have permits are able to sell excess permits on market. The EU ETS is an example of a cap and trade scheme.

Under a baseline and credit scheme, liable parties are assigned an emissions path or 'baseline' which sets out allowable emissions over time. The difference between the baseline and 'business as usual' emissions is the targeted reduction in emissions. Tradeable permits are allocated with reference to the baseline. The NSW Greenhouse Gas Abatement Scheme (GGAS) is an example of a baseline and credit scheme.

In practice, there are many similarities between the two categories of schemes. For simplicity, the following analysis focuses on cap and trade schemes.

The design features of particular importance in determining the financial impact of a carbon pricing scheme are:

- Sectors / sources and types of emissions covered; and
- Permit allocation method.

## 3.1 Emissions/Sector Coverage

Electricity generation is typically the focus of carbon pricing proposals, due to:

- The size of emissions from this sector (35% of Australia's greenhouse gas emissions in 2004);
- The comparative administrative simplicity of applying emission controls; and
- The low risk of import substitution.

Emissions from electricity generation may be the only emissions covered by a carbon pricing scheme. Alternately, proposals may cover emissions from other stationary sources as well as emissions from industrial processes (including clinkering), fugitive emissions and from transportation.

While, in theory, it would be possible to have a carbon pricing scheme that covered all sources of greenhouse emission, this presents significant practical difficulties. The costs and difficulties associated with measuring greenhouse gas emissions from waste, agriculture and land clearing, make it unlikely that emissions from these sectors would be included in any carbon pricing scheme. No economy-wide carbon pricing schemes have been implemented anywhere in the world.

Carbon pricing may be 'phased in' – applying to a small number of sectors initially, with additional sectors included at a later stage. For example, the EU ETS initially imposes controls only on:

- Large electricity generating units (over 20MW);
- Oil refineries; and
- Manufacturers of iron and steel, cement, brick, tile, glass, pulp and paper.

Consideration is being given to expanding the EU ETS to other sectors, such as aviation, from the beginning of the second or third phase (2008 and 2013 respectively).

Emissions / sector coverage determines who has direct liability under a carbon pricing scheme and for what emissions. Where covered sectors provide inputs to other parts of an economy, this creates indirect exposure to the scheme for those downstream of covered sectors. This indirect exposure can be highly significant. Carbon pricing of electricity generation emissions has the potential to impact across the economy, as electricity is an input to production for every industry, to a greater or lesser extent.

# 3. Impact of a Carbon Price on the Construction Materials Sector

## 3.2 Permit Allocation

A variety of permit allocation methods can be used. Typically this will involve some combination of:

- Auctioning – where liable parties are required to pay a market price for tradeable permits through an auctioning process.
- 'Free' allowances – where permits are allocated to liable parties for free. The basis of this free allocation may be historical emissions or average emissions intensity and actual production levels. Free allocation on the basis of historical emissions is also referred to as 'grandfathering', as some emissions are allowed to continue without attracting a penalty (or carbon price).

In the first phase of the EU ETS allocations have been made using free allowances only. The cap established was around 10% lower than 'business as usual' emissions, resulting in only a small net liability for liable parties, which can be met either through reducing emissions or trading for permits on the market.

Experience with the EU ETS to date has revealed one of the problems with free allowance allocations. Each liable party was granted free allowances for the bulk of expected emissions. Thus, each had only a small net liability and was facing only a small increase in costs to meet the liability under the scheme. However, each of the free allowances has value – it can be sold at the prevailing carbon price. Liable parties took the value associated with the free allowances into account when setting prices for sales after the scheme was introduced. Where they could raise prices to compensate for the lost opportunity to sell the free allowances, they did so, leading to larger price increases than were necessary to cover real cost increases.

In the case of electricity, generators have been highly successful in achieving price increases due to the relative inelasticity of electricity demand (that is, price rises typically result in only small decreases in consumption). This has resulted in a windfall profit for many generators, estimated to total £800 million p.a. in phase one of the EU ETS for the UK power generation sector.[xix]

Other forms of permit allocation, such as auctioning or free allocations on the basis of sector average emissions intensity and actual production levels, have the potential to reduce or eliminate such windfall profits. In the second phase of the EU ETS, some governments are proposing to use auctioning to the extent necessary to recoup gains expected from opportunity cost pricing, with the balance of permits allocated as free allowances.

Thus, when carbon trading is implemented in Australia, the method of permit allocation has the potential to alter the financial impact on various industry sectors including construction materials, both in relation to direct compliance costs and in relation to the indirect exposure to electricity price rises.

## 3.3 Modelling Scenarios – Australian Cement Industry

Insufficient greenhouse data is publicly available for the majority of companies in the construction materials sector to enable modelling of possible carbon price impacts. Accordingly, the cost of carbon pricing has been estimated for the Australian cement industry only (Australian production reported by the Cement Industry Federation). Thus, results represent only a portion of the total exposure for companies in the construction materials sector.

The cost of carbon pricing for the Australian cement industry has been estimated for four possible scenarios, which are described in Table 5.

# 3. Impact of a Carbon Price on the Construction Materials Sector

**Table 5: Summary of Emissions Trading Scenarios Used in Analysis**

| Scenario | Emissions Covered | | | | Permit Allocation Method | Other Comments |
|---|---|---|---|---|---|---|
| | Direct Combustion | Direct Process | Indirect Electricity | % of Total Emissions Covered | | |
| 1 | YES | YES | YES | 100% | 100% auctioning | |
| 2 | YES | NO | YES | 45% | 100% auctioning | |
| 3 | YES | YES | YES | 100% | 90% free allowances | Allowances based on historical emissions.<br>Electricity generators are assumed to follow opportunity cost pricing. |
| 4 | YES | YES | YES | 100% | 90% free allowances | Allowances based on sector average emissions intensity and actual production levels.<br>Electricity generators are assumed to recover only costs of compliance (no opportunity cost pricing). |

Scenario 1 represents a carbon pricing scheme, where liable parties are required to pay a carbon price (via auction) for 100% of greenhouse gas emissions (direct and indirect emissions) in Australia. While this is close to the full potential liability for carbon pricing and is possible in the long run, such a scenario is highly unlikely in the short or medium term, where it is envisaged that a proportion of permits will be allocated free to liable parties.

Scenario 2 is similar to scenario 1 but only involves carbon pricing of combustion emissions only – including direct combustion emissions and indirect emissions from electricity generation. Process emissions from cement production (clinkering) are excluded from liability.

Under both scenario 3 and 4, 100% of greenhouse gas emissions (direct and indirect emissions) are covered, but free allowances are granted for the majority (90%) of emissions, resulting in a net liability equivalent to 10% of 'business as usual' emissions. This relatively modest net reduction target is consistent with an initial phase of a potential carbon pricing scheme.

The difference between scenarios 3 and 4 is that in scenario 3 it is assumed that electricity generators engage in 'opportunity cost pricing' such that they over-recover the cost of carbon and make a windfall gain, as experienced under phase one of the EU ETS. In scenario 4, this windfall gain is assumed to be eliminated through alternative permit allocation approaches.

In each scenario, the impact is modelled for three example carbon prices:

- $5 per tonne of $CO_2$-e – approximately the price of credits under voluntary trading schemes, such as the Australian Greenhouse Office's Greenhouse Friendly Program and the Chicago Climate Exchange.[xx]
- $10 per tonne of $CO_2$-e – approximately the spot price of a carbon credit under the New South Wales Greenhouse Gas Abatement Scheme.[xxi]
- $25 per tonne of $CO_2$-e – the average spot price in June 2006 for credits under the EU ETS.[xxii]

In each scenario it is assumed that:

- Only company operations in Australia are covered by the trading scheme.
- Financial impact is assessed at a sector level. The financial impact on a company or individual operations/divisions of a company maybe significantly different from that given for the sector as a whole.
- Production levels, product mix, and technology remain constant. Changes in these factors may impact energy consumption and greenhouse gas emissions.
- All of the six main greenhouse gases are controlled. The most likely alternative to this is control of carbon dioxide emissions only. In the case of the cement industry, the majority of emissions are of carbon dioxide, so this assumption is not expected to have a significant impact on results.

# 3. Impact of a Carbon Price on the Construction Materials Sector

- The carbon price liability is met by purchasing credits on market, rather than through direct reductions. Therefore, excluding administrative costs, estimates represent the maximum costs of compliance. The potential for cement producers to reduce emissions and, therefore, reduce the compliance cost is discussed below under heading 4.4 Risk Mitigation Opportunities.

- Estimated greenhouse gas emissions by the Australian cement industry are as follows:
  - Total emissions are approximately 6.5 million tonnes $CO_2$-e.
  - Direct combustion emissions represent 32%, direct process emissions 55%, and indirect electricity emissions 13%.
  - For further details about how emission estimates were developed see Appendix: Methodology Notes.
- Average net profit margins on cement are 20% mid cycle and 16% low cycle. It is noted that margins for individual producers may vary from these values.

The model used to calculate the total cost of carbon to the Australian cement industry is outlined in Appendix One: Methodology Notes.

## 3.4 Modelling Results

The total cost for greenhouse gas emissions from the Australian cement industry (in relation to operations and electricity use in Australia) ranges from $163 million p.a. at a carbon price of $25 in scenario 1 down to $3 million p.a. at a carbon price of $5 under scenario 4.

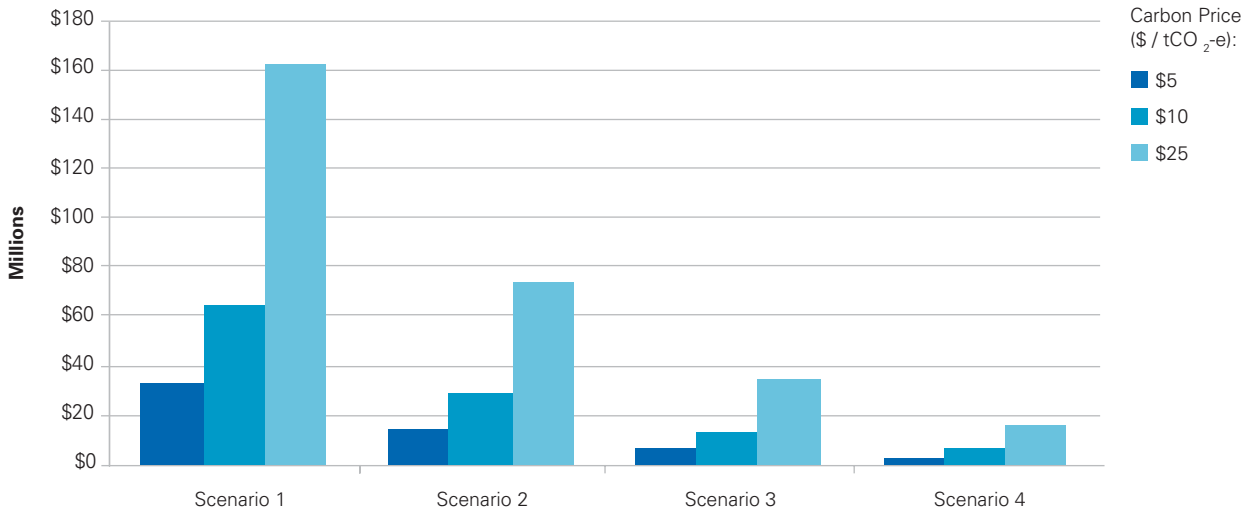
Irrespective of the carbon price, the results indicate the importance of the permit allocation method in determining the financial implications of an emissions trading scheme.

The cost of carbon, before considering cost pass through or emission reduction action, represents a potential reduction in mid-cycle net profit margins of between:

- 60% (declining from 20% to 8%) at a carbon price of $25 in scenario 1; and
- 1% (declining from 20% to 19.8%) at a carbon price of $5 under scenario 4.

Modelled results are for the cement industry. The impact at the company level may vary significantly from the sector wide result, as companies have different exposures to carbon pricing (as outlined in Section 4).

**Chart 4: Total Annual Cost of Carbon to the Australian Cement Industry**
(Carbon price applied to emissions from all facilities located in Australia only)



# 3. Impact of a Carbon Price on the Construction Materials Sector

**At the highest carbon price modelled ($25 per tonne $CO_2$-e):**

- Scenario 1 results in the highest cost of carbon of $163 million p.a. (see Chart 4). This is equivalent to a reduction in the mid-cycle net profit margin of 60% (from 20% to 8.0%) (see Chart 5) and low-cycle net profit margin of 79% (from 16% to 3.4%) before considering cost pass through or emission reduction action. As noted above, this scenario represents close to the full potential liability for carbon pricing for the sector, but it is highly unlikely that liable parties will be required to pay for 100% of emissions in the short or medium term.
- In scenario 2, process emissions from cement manufacture, which comprise approximately 55% of sector greenhouse gas emissions, are excluded from liability. This results in a significant reduction (more than 50%) in the total cost of carbon to $74 million p.a. (see Chart 4), reducing net profit margins by 27% mid cycle (from 20% to 14.6%) (see Chart 5) and by 36% low cycle (from 16% to 10.3%).

**Chart 5: Percentage Change in Mid-Cycle Net Profit Margins**

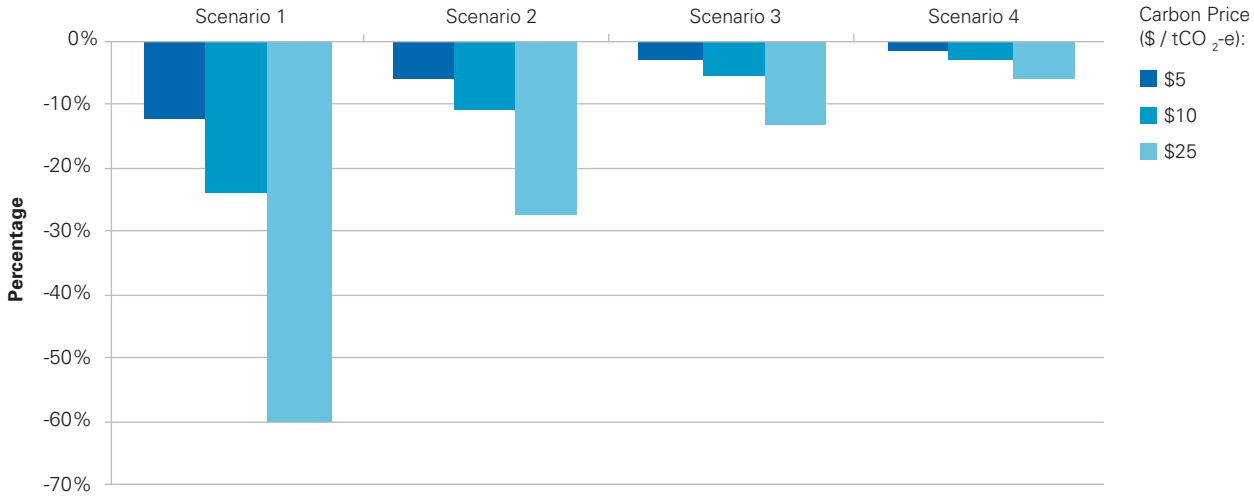
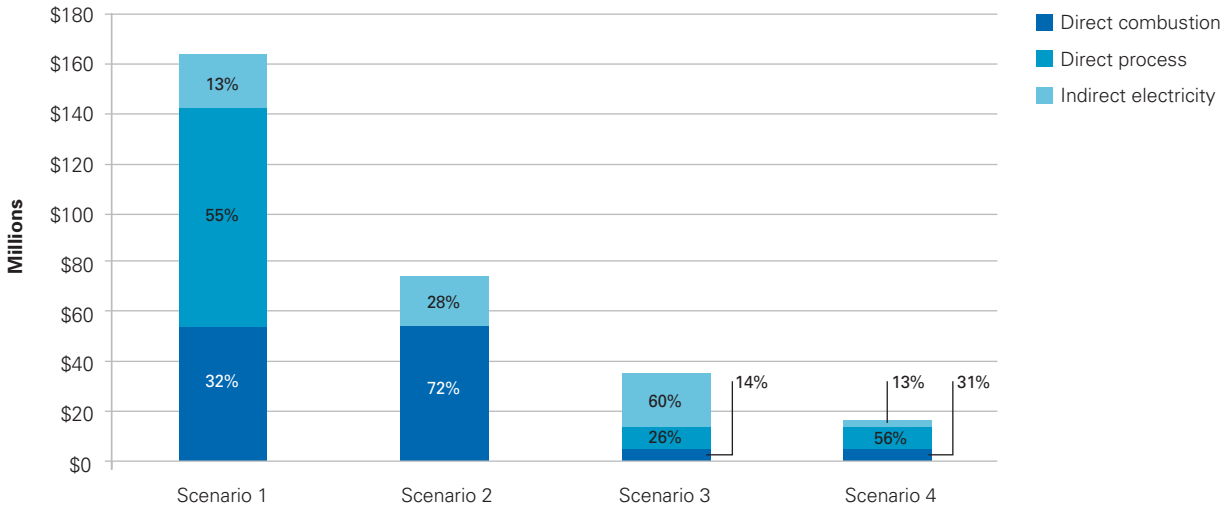
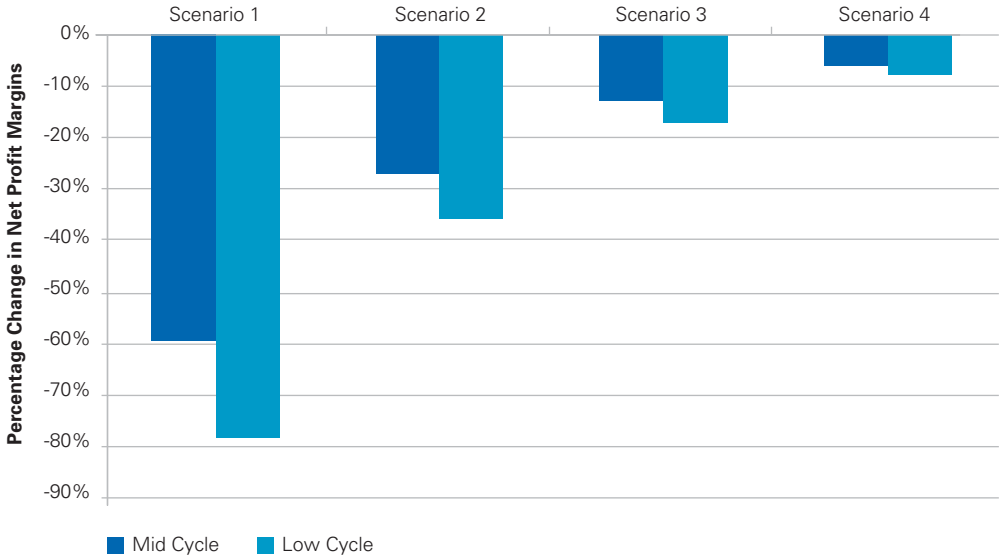



**Chart 6: Annual Cost of $25 Carbon Price to the Australian Cement Industry**



# 3. Impact of a Carbon Price on the Construction Materials Sector

**Chart 7: Impact of $25 Carbon Price on Net Profit Margins**




- Under scenario 3 where all major emission sources are included, but free allowances are allocated for 90% of emissions, the total cost of carbon is estimated to be $35 million p.a. (see Chart 6). The majority of this total cost (60%) relates to electricity emissions because electricity generators are assumed to engage in 'opportunity cost pricing' such that they seek to recover the cost of carbon in relation to 100% of their emissions.
- In scenario 4, this opportunity cost pricing is assumed to be eliminated. This significantly reduces the impact of carbon pricing (with the entire change attributable to a reduction in indirect exposure from electricity consumption). The total cost of carbon declines from $35 million p.a. in scenario 3 to $16 million p.a. in scenario 4 (see Chart 6).

As noted above, modelling has been conducted for the Australian cement industry only, due to poor data availability for other parts of the construction materials sector. Thus, these results only represent a portion of the total exposure for the sector.

- The construction materials sector of the S&P/ASX200 has significant greenhouse gas emissions arising from production of other construction materials both in Australia and globally.

In the case of the non-cement emissions, carbon price impacts may differ significantly from modelled estimates. Many construction materials have a very high proportion of total emissions associated with electricity consumption. This creates particular sensitivity to the scenarios where:

- A high proportion of electricity emissions are controlled (scenarios 1 and 2); and
- Electricity generators engage in opportunity cost pricing (scenario 3).

Cement is a key input into the production of other construction materials, in particular, concrete and fibre cement products. These products have high indirect emissions associated with the cement input. Thus, they are particularly exposed to any carbon price impact on the cement industry flowing through as higher input prices.

# 3. Impact of a Carbon Price on the Construction Materials Sector

## 3.5 Impact of Modelling Assumptions

### 3.5.1 Emissions Coverage

Modelling has considered direct emissions and indirect electricity emissions. Thus, in the modelling '100% emission coverage' refers to total direct and indirect electricity emissions being included within the scheme. These emissions together account for the majority of emissions in the cement industry supply chain. As other indirect emissions are relatively minor, the carbon pricing scheme, where all greenhouse gas emissions, including 'other indirect emissions' are subject to controls, would only increase the impact by a relatively small amount.

### 3.5.2. Carbon Prices

Results are sensitive to the carbon price assumptions. The carbon prices modelled are all based on prices in currently operating carbon markets.

Future carbon prices are highly uncertain, especially in the absence of specific regulatory proposals. Forecasts of future carbon prices vary significantly depending on the assumptions adopted. Recent attempts to model carbon price outcomes resulted in estimates of:

- $186 per $tCO_2$-e in 2050 – Allen Consulting Group modelling of an 'early action' scenario to reduce greenhouse gas emissions by 60% from year 2000 levels by 2050.[xxiii]
- $77 to $525 (2005 A$) per $tCO_2$-e in 2050 – ABARE modelling across a range of scenarios to reduce global $CO_2$ emissions by 40% by 2100 relative to the reference case.[xxiv]

These variations result in part from different reduction targets contemplated, but also reflect the uncertainty about how costly it will be to achieve the targeted greenhouse gas reductions.

The modelling in this report treats the carbon price as independent of other aspects of the carbon pricing regime such as sector coverage and the emissions 'cap' (or reduction target). However, in practice, carbon prices are determined by supply and demand for tradeable permits and demand is strongly affected by a range of factors including sector coverage and the emissions cap.

# 4. Assessing Individual Company Exposure to Climate Change Risk

In assessing the exposure of a company to climate change risk, consideration should be given to how exposure varies with each of the following elements:

1. Proportion of business subject to or likely to be subject to a carbon price – geography;
2. Emissions intensity of products and technology;
3. Ability to pass through cost; and
4. Risk mitigation opportunities.

Assessing exposure in relation to regulation that imposes a carbon price, which is considered to be an imminent risk associated with climate change, is described below. Other exposures are outlined briefly below under heading 5. Other Climate Change Risks

## 4.1 Proportion of Business Subject to or Likely to be Subject to a Carbon Price – Geography

Exposure to carbon price risk varies across the jurisdictions where emissions occur, depending on the likelihood and design of a carbon pricing scheme.

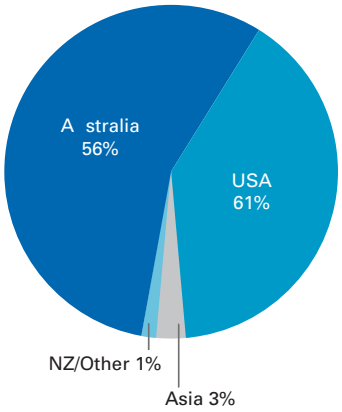
Generally, countries that have committed to greenhouse gas reduction targets under the Kyoto Protocol present the highest likelihood of carbon pricing. However, there is no requirement on ratifying countries to establish domestic carbon pricing schemes and some ratifying nations intend to achieve their reductions without imposing any form of carbon price regulation.

Equally, some jurisdictions that are not bound to reduction targets have proposed or introduced carbon pricing. For example, California has committed to implementing a carbon trading scheme.

The Californian example also demonstrates the potential for carbon price regulation to vary within a country – from region to region – as state and territory governments choose to implement carbon pricing where no national scheme is planned.

Accordingly, in assessing exposure to carbon price risk, it is necessary to gain an understanding of the jurisdictions in which significant emissions arise and the potential for carbon price regulation to be introduced in those jurisdictions. Ideally, an emissions profile would be developed for each jurisdiction in which there is significant emissions, to facilitate exposure analysis.

**Chart 8: Share of Sector EBITDA by Region - Construction Materials Sector**




Of the four construction materials companies in the ASX/S&P200, only Boral publicly reports greenhouse gas data in sufficient detail to analyse the geographic spread of emissions. As such the figure (above) is the geographic spread of building materials earnings (EBITDA) for the sector, which is used as a proxy for greenhouse gas emissions. As shown, the sector has significant exposure to Australia and USA, and very small exposure to New Zealand and Asia.

The USA has not ratified the Kyoto Protocol. Despite this, there has been growing action in the US Congress on climate change with 125 bills, resolutions, and amendments, addressing climate change and greenhouse gas emissions introduced in the 110th congress, including a number of carbon trading proposals.[xxv] In addition, numerous US state governments have committed to introducing carbon pricing regulation.[xxvi]

Australia has not ratified the Kyoto Protocol, but has nonetheless stated its intention of meeting its Kyoto target (of increasing emissions by no more than 8% over 1990 levels over the period 2008-2012). On 3 June 2007, the Prime Minister announced that Australia will move towards a national emissions trading system beginning no later than 2012.[xxvii]

New Zealand has ratified the Kyoto Protocol but does not currently propose to introduce a domestic emissions trading scheme.

Japan is the only Asian country that has a binding reduction target under the Kyoto Protocol. It is primarily pursuing voluntary measures and is actively purchasing carbon credits from overseas. It is not considered likely that domestic carbon price regulation would be introduced in any Asian jurisdiction in the short or medium term.

# 4. Assessing Individual Company Exposure to Climate Change Risk

## 4.2 Emissions Intensity

### 4.2.1 Products

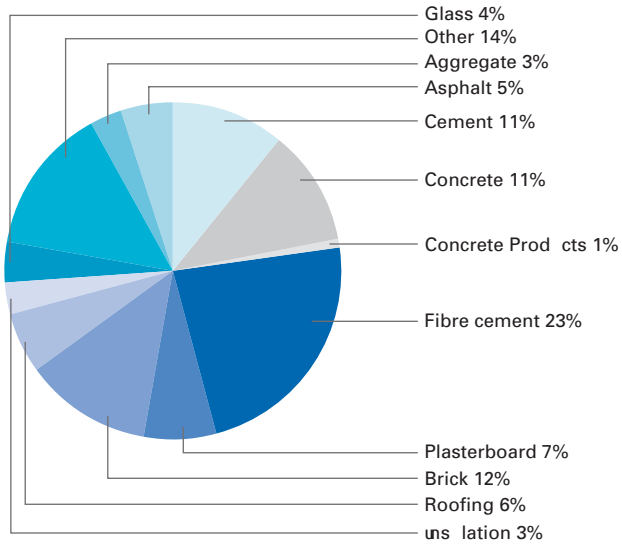
As different products have significantly different greenhouse gas emissions intensities it is important to understand the product mix of the sector or company being analysed.

A breakdown of external revenues by product for the construction materials sector of the S&P/ASX200 is presented in the chart below.[xxviii]

Cement provides 11% of external revenues. Cement has a high greenhouse gas intensity and, therefore, is significantly exposed to carbon price risk.

In addition, a substantial portion of external revenues (a further 35%) comes from products that rely on cement as a key input into production (concrete, concrete products, and fibre cement). These products are also exposed to carbon pricing indirectly through the emissions from the cement input.

**Chart 9: External Revenue by Product – Construction Materials Sector**




The majority of products that provide the remainder of external revenues for the sector (54%) have comparatively low greenhouse intensities, and far lower exposure to carbon price risk.

However, this sector level view masks significant differences in product mix at the company level. For example, the share of cement in external revenues ranges from 0% to 59% for individual companies within the sector.

### 4.2.2 Technology

Production process technology for a particular construction material can vary significantly with respect to both energy sources and energy efficiency. Thus, in assessing exposure to carbon price risk, it is important to understand the mix of processing technologies used.

**Table 6: Cement Production Technology in Australia[xxix]**

| Technology | Share of Clinker Production 2004 |
|---|---|
| Precalciner dry process | 74% |
| Other dry process | 10% |
| Wet kiln process | 16% |

For cement production, specifically the manufacture of clinker, the main technology used in Australia is the precalciner dry process (74% of clinker production 2004). This technology is highly energy efficient using only around 3.5 GJ per tonne of clinker produced, compared to the least energy efficient wet kiln technology (16% of 2004 production) which uses around 5.7 GJ per tonne clinker.[xxx]

For brick manufacture, continuous firing tunnel kilns are the predominant kiln technology in use in Australia, mostly fuelled by natural gas. Down draught kilns are an alternative batch firing technology. Continuous firing kilns are more energy efficient than batch firing. On a life cycle basis, production of a tonne of bricks using a modern gas-fired tunnel kiln uses around 3 GJ of energy.[xxxi]

# 4. Assessing Individual Company Exposure to Climate Change Risk

The manufacturing technology influences both the total amount of greenhouse gas emissions and the types of emissions, as outlined below.

**Table 7: Summary of Emissions Type and Exposure**

| Emissions Type | Indicator of | Construction Materials Exposed |
|---|---|---|
| Direct (including both combustion and process emissions on site) | Exposure to regulation of direct emissions | Cement in relation to both fuel combustion and process emissions from clinkering.<br>Brick in relation to fuel combustion.<br>All in relation to transport fuels used on site. |
| Indirect – electricity | Exposure to regulation of electricity sector emissions | All – degree of exposure indicated by electricity intensity of production. |
| Other indirect | Exposure to regulation of emissions by other sectors | Fibre cement and concrete exposed to regulation of cement industry emissions.<br>All in relation to fuels used in transporting raw materials and finished goods. |
| Total | Exposure to comprehensive economy-wide emissions regulation | All – degree of exposure indicated by total greenhouse intensity of production. |

## 4.3 Ability to Pass Through Cost

### 4.3.1 Directly

The impact of a carbon price will depend upon the extent to which the increased costs can be passed on to customers without reducing profits. Thus, in assessing the impact of carbon pricing, it is critical to understand the ability of the company to pass through costs.

In general, the impact will be highest for companies that have a high exposure to internationally traded commodities/ undifferentiated products. Companies that have a high exposure to this type of international trade, especially those with competitors in countries without greenhouse emissions controls (with no need to increase prices), are price takers and any increase in costs may not be able to be passed through to customers.

Generally construction materials are manufactured close to the markets served as transportation costs can be significant and act as a barrier to imports. However, the Australian construction materials sector faces some risk of import substitution, as most markets are close to the sea and sea transport is cheaper than land transport. This is increasingly the case due to increasing production capacity in Asia, especially for cement. Further, the risk of import substitution will be higher in times of weak global demand, where there is greater excess capacity.

Producers with a greater proportion of more highly finished products may have a comparative advantage at passing through cost increases, as these products are more differentiated and, thus, are less exposed to substitution.

### 4.3.2 Via Other Activities or Products

While greenhouse gas emissions arise throughout the construction materials supply chain, the vast majority of emissions arise in manufacturing processes. As such, the majority of carbon price exposure relates to manufacturing. Involvement in other stages of the value chain reduces greenhouse gas intensity of earnings and, hence, exposure to carbon price risk.

For example, for cement-based products, the majority of emissions arise in clinker production. Cement producers that are involved in value adding, for example, manufacture of concrete products (such as, concrete block and tile) will have lower greenhouse intensity of earnings. In addition, such producers have the ability to spread the cost of carbon across activities and to choose on what products the carbon price is recovered, for example, recovering additional cost on higher-value finished products, where the carbon cost represents a smaller proportion of the price of the finished product.

If carbon pricing in Australia were to increase the cost of manufacturing clinker in Australia compared to importation, Australian producers may be able to import clinker for grinding and further processing in Australia. Due to the high degree of vertical integration evident in the Australian cement industry, it is likely that the major producers would have sufficient volume requirements to make importation viable.

# 4. Assessing Individual Company Exposure to Climate Change Risk

## 4.4 Risk Mitigation Opportunities

The cost of a carbon price can be greatly reduced through reducing greenhouse gas emissions (also referred to as emissions abatement). Thus, in assessing exposure to carbon price risk it is important to understand the company's ability to reduce emissions. Greenhouse gas emissions abatement may also be a revenue generation opportunity. Where reductions in excess of any mandatory requirements are able to be made, excess carbon credits can be sold, providing a new source of revenue.

Abatement opportunities differ between products.

The Australian cement industry has achieved year-on-year reductions in greenhouse gas emissions through a variety of means, in particular, through adoption of more energy efficient technology and through fuel switching, such as increasing the use of natural gas to replace coal.

Some companies have also begun utilising alternative fuels (such as industrial waste, used tyres, and biomass). The carbon impact of alternative fuel use will depend on the relative greenhouse intensity of original and substitute fuels, for example, use of biomass results in zero greenhouse gas emissions when it is diverted from landfill. However, currently in Australia much of the alternative fuel use is from relatively greenhouse intensive sources such as car tyres.

Opportunities to achieve further emissions reductions remain in all of these areas (see Table 8).

**Table 8: Comparison of Australian Cement Industry (CIF) to World's Best Practice[xxxii]**

| Indicator | CIF 2004 | Best Practice |
|---|---|---|
| Electricity (kWh/t cement) | 106 | 80 |
| Fossil fuel use (GJ/t cement) | 3.6 | 3 |
| Alternative fuels (% substitution) | 6 | 60 |
| Total SCM use (% substitution) | 22 | 40 |
| Greenhouse gas emissions ($tCO_2$/t cement) | 0.824 | 0.460 |

A key opportunity to reduce greenhouse gas emissions is through further expanding the use of clinker alternatives (supplementary cementitious material or SCM). Total use of SCM by the Cement Industry Federation (CIF) is predicted to increase from 22% in 2004 to 29% by 2012. World's best practice is currently 40% SCM use.[xxxiii] SCMs are usually waste materials, such as steel blast furnace slag and fly-ash produced by coal electricity generation. Thus, SCM use has multiple environmental benefits by providing a productive use for waste materials. Greenhouse gas emissions reductions are directly proportional to the amount of SCMs used. The CIF estimates that a further increase of 10% will save 500 kilotonnes of greenhouse gas emissions annually.[xxxiv]

In the longer term, new technologies, such as fluidised bed kilns and carbon capture and storage, may provide further emission reduction opportunities.

Because other construction materials have a higher proportion of emissions from indirect sources (in particular, electricity), reduction opportunities are likely to be more limited.

### 4.4.1 Risk Mitigation – Good Practice Examples

Companies in the Australian construction materials sector are implementing a range of approaches to mitigating and managing climate change risk.

The CIF has taken a leadership role in responding to greenhouse issues. The CIF is comprised of:

- Adelaide Brighton;
- Blue Circle Southern Cement (wholly owned by Boral); and
- Cement Australia. (JV between Holcim, Heidelberg Cement and Cemex)

The CIF has been a Greenhouse Challenge Member since 1997. Through participation in the Greenhouse Challenge, the CIF has developed a comprehensive greenhouse inventory (which is externally verified and consistent with global best practice frameworks) and a thorough understanding of its greenhouse exposure. All CIF members have adopted a Greenhouse Energy Management System – a program with a defined methodology for identifying and evaluating greenhouse gas emissions reduction projects. From 1990 to 2005, reductions in greenhouse gas emissions of 24% per tonne of cementitious product were achieved, equivalent to an absolute carbon dioxide emissions abatement of almost 1.5 million tonnes.[xxxv]

# 4. Assessing Individual Company Exposure to Climate Change Risk

Adelaide Brighton has undertaken a number of alternative energy and alternative raw materials projects that have led to greenhouse gas emissions reductions. For example, at its Angaston plant, diminishing supplies of Birdwood clay prompted the search for an alternative raw material for Brightonlite cement. Blast furnace slag has now replaced the clay, reducing carbon dioxide emissions and conserving natural resources.

Boral's public environmental reporting includes detailed information on energy and climate change risk mitigation and management and quantitative emissions data. Boral is also an elective participant in the NSW Greenhouse Gas Abatement Scheme. This means that it has chosen to be directly responsible for the greenhouse liability associated with its electricity consumption, rather than the electricity retailer meeting the liability and passing through the costs. By directly participating in the scheme, Boral is able to better understand and manage its cost exposure and gain valuable experience in the operation of a carbon pricing scheme. Liability under the scheme has largely been met by Boral's Berrima kiln upgrade, which has resulted in approximately 145 kilotonnes of reduced carbon dioxide emissions each year.[xxxvi]

CSR has invested extensively in renewable energy generation using sugar waste. The energy is used on site, reducing CSR's indirect greenhouse gas emissions (from electricity) and enabling it to create and sell renewable energy credits and carbon credits, providing a new revenue stream.

# 5. Other Climate Change Risks

Climate change presents multiple risks to company earnings, through a number of different exposures. This report has focused particularly on carbon price risk, which is considered to be a key risk and which is also increasingly imminent. While physical damage to infrastructure and operations is also a risk to the Australian construction materials sector it is only outlined briefly below as it is covered more extensively in existing literature. Other risks associated with climate change such as other regulation, market risk, and litigation are also briefly outlined below.

Each exposure and the potential impact on companies in the construction material sector is discussed.

## 5.1 Exposure to Direct Climate Impacts

Climate change is expected to make extreme weather events both more frequent and more severe. Such impacts are expected to cause damage to assets and infrastructure and lead to business and supply chain interruption.

Also, more frequent and extreme weather events are already leading to increases in insurance premiums. Climate change is expected to accentuate this trend and to lead to an increasing number of weather-related risks becoming uninsurable.

Extreme weather events are also likely to lead to disruptions in the supply chain. For the construction materials sector, the most significant supply chain exposure from climate change is an increase in weather-related construction delays, which is capable of causing material impacts on sector earnings. On the upside, an increase in weather-related disasters is expected to increase demand for construction materials for rebuilding efforts and may create other opportunities:

- In the US, hurricane activity is helping to shift demand toward concrete block construction in affected areas, away from traditional lighter weight materials.[xxxvii]
- It is also expected that storm water infrastructure will need to be enhanced, leading to improved growth prospects for concrete pipe.

While the effects of rebuilding efforts on demand from a particular disaster may be short-lived, they may also be material and climate change is expected to lead to such impacts becoming more frequent, potentially increasing the variability of earnings.

## 5.2 Climate Change Regulation other than Carbon Pricing

There is a growing range of regulation, other than carbon pricing, aimed at addressing climate change and at increasing disclosure by companies of their exposure. This other regulation includes:

- Stringent approvals for new project for greenhouse/ energy intensive industries; or
- Minimum standards and labelling of greenhouse/energy intensive products.

In Australia, a range of climate change related regulation has already been introduced, for example:

- Schemes that promote the uptake of renewable energy, such as the Federal Mandatory Renewable Energy Target (MRET) and the Victorian Renewable Energy Target (VRET), which both place obligations on energy retailers to buy a minimum proportion of renewable energy.[xxxviii]
- The Greenhouse Challenge, which requires emissions reporting and reduction initiatives, has recently become compulsory for Australian companies receiving fuel excise credits of more than $3 million.[xxxix]
- The Federal Government's Energy Efficiency Opportunities program, which commenced in July 2006, requires large energy users to undertake energy audits and develop and report against action plans to reduce energy consumption.[xl]

Ongoing rapid growth in emissions, along with increasing concern about the impacts of climate change, continues to create the impetus for new regulatory responses.

## 5.3 Exposure to Market Risk

Increasingly companies are facing market risks related to climate change. In addition to demand for low emissions 'green' products and the risk of consumer boycotts of greenhouse-intensive products, climate change regulation can also impact on demand.

The most significant market exposure from climate change for construction materials is considered to be changes in building regulations and practices that seek to reduce the operational energy requirements of buildings.

Operational energy refers to energy used in providing cooling, warmth and light to building users over a building's life. The operational energy requirements of residential and commercial buildings contribute around 15.3% of total global greenhouse gas emissions.[xli]

# 5. Other Climate Change Risks

The Australian Government, together with the building industry, has developed a strategy aimed at making Australian buildings more energy efficient. The strategy encompasses:

- Support to encourage voluntary best practices in building design, construction and operation; and
- The elimination of worst energy performance practices by incorporating a single standard for minimum performance requirements in the Building Code of Australia.

Minimum energy efficiency standards were first introduced into the Building Code of Australia in 2003. In addition, there are numerous state and local government and voluntary initiatives on building energy efficiency. It is expected that the minimum standards for new building energy efficiency will be consistently raised over time, creating increasing demand for products that add to operational energy efficiency.

In building applications, choice of construction materials, as part of design, can have a strong influence on operational energy requirements and, hence, on greenhouse gas emissions. Reducing greenhouse gas emissions over the building's life may not necessarily mean use of materials with lower greenhouse intensity in manufacture. In fact, materials with higher greenhouse gas intensity may ultimately assist in reducing greenhouse gas emissions over the buildings life. This is because savings in operational energy and greenhouse emissions over the building's life from use of a particular construction material may more than offset the greenhouse emissions associated with manufacture of the material. For example, concrete slab and double brick construction both add to thermal mass and this can create operational energy and greenhouse savings in climates where the predominant energy requirement is heating, such as those experienced in Victoria and Tasmania.

Other factors that influence total energy requirements and emissions include:

- Durability or expected life span of the material;
- Maintenance requirements; and
- Recyclability of material used in the construction process.

Recycling can enable significant energy savings, although the savings vary between materials. For example, savings may be up to 95% for recycled aluminium, but only 20% for recycled glass.[xlii] So, from a life cycle perspective, the impact of materials with high process energy requirements and high recyclability may be lower than materials with lower process energy requirements and low recyclability.

In this way, an assessment of greenhouse gas emissions over a product's life is necessary to understand the full exposure or opportunity of a particular product to market risk from climate change. Companies that actively seek to position their products as greenhouse friendly and support this with robust analysis and action to reduce negative impacts may be able to create competitive advantage.

## 5.4 Exposure to Climate Change Litigation

Climate change litigation can involve actions against:

- Governments – seeking to influence policy or force action to limit greenhouse gas emissions, such as requiring climate change to be considered in environmental approval processes; or
- Businesses – seeking to impose liability for their contribution to climate change, following the example of tobacco and asbestos cases.

Australia has already seen several cases that have sought to stop new projects on the grounds of their greenhouse gas emissions.[xliii]

Potential for litigation is greatest for companies whose products or operations are identified as being greenhouse intensive. Showing leadership on climate change, in particular by taking action to minimise emissions, can help to reduce exposure. Climate change litigation is considered an emerging and growing risk.

# 6. Summary and Conclusions

**The construction material sector is greenhouse intensive and this creates exposure to climate change risk, and in particular the risk of a carbon price. However, disclosure of greenhouse gas emissions in the construction materials sector is generally poor and this currently limits the ability to analyse the significance of this exposure at the sector and company level.**

Modelling shows that if cement manufacturing companies were required to pay for permits for 100% of greenhouse gas emissions (full auctioning) from Australian facilities the cost at a carbon price of $25 per tonne $CO_2$-e would be equivalent to a reduction of 79% in low-cycle net profit margins (reducing from 16% to 3.4%) before considering cost pass through or emission reduction action.

Modelling results for the Australian cement industry represent only a portion of the total exposure for the construction materials sector of the S&P/ASX200, as the sector has significant greenhouse emissions that also arise from production of other construction materials both in Australia and globally.

Exposure for cement is primarily in relation to direct greenhouse gas emissions. For other construction materials the majority of emissions and exposure is indirect – related to electricity consumption and other emissions intensive inputs, such as cement, to production.

It is unlikely in the short term that any scheme introduced would require companies to pay for 100% of greenhouse gas emissions. A more likely scenario is that a proportion (and possibly a large proportion) of the permits will be allocated for free. Thus, near-term impacts are likely to be at the lower end of the modelled range.

Under a scenario with a low carbon price ($5 per tonne $CO_2$-e ) and a large amount (90%) of permits allocated free, the cost to the cement industry is equivalent to a reduction of only 1% in mid-cycle net profit margins (reducing from 20% to 19.8%) before considering cost pass through or emissions reduction action.

The modelling in this report suggests that the potential cost of carbon pricing to the construction materials sector can be significantly reduced through the design and implementation of the carbon pricing scheme. Two key design issues are the emissions covered and the permit allocation method. Modelling shows that where permits are allocated in such a way as to eliminate opportunity cost pricing the impact of carbon pricing on the cement industry reduces by nearly 50%, in the early years of a trading scheme.

The industry level impact will not be shared equally across all companies. The key driver of exposure at the company level is the proportion of emissions intensive products located in countries likely to be subject to emissions controls. In addition, producers with more highly finished (value added) products are likely to have lower emissions intensity and greater ability to pass through costs.

There is also scope for producers to reduce exposure to carbon pricing through reducing emissions intensity. Emissions reduction opportunities differ between products and depend on the particular technology and production processes in use. For the cement industry, key abatement opportunities relate to continued increases in the use of supplementary cementitious material and switching to lower greenhouse gas intensive fuels.

This report has focussed on one particular climate change exposure (carbon price risk), but climate change presents multiple risks to company earnings. Many climate change risks remain difficult to quantify. In part, this is due to uncertainty about the size, nature and timing of impacts. However, the key impediment to analysing the impact of climate change risk on value at the company level is availability of the relevant information. While leading companies are voluntarily publicly reporting on greenhouse gas emissions, climate change exposure, mitigation and management, the quality of disclosure varies and many companies do not report at all. Initiatives, such as the Carbon Disclosure Project seek to increase the level of voluntary disclosure by communicating to companies the importance of this information to investors and providing guidance about what should be disclosed.

# Appendix: Methodology Notes

## Greenhouse Gas Emissions Estimates

Greenhouse gas emissions estimates presented in this report have been developed using data from a variety of sources.

Wherever possible, data sourced directly from relevant Australian companies has been used. For the Australian cement industry, Cement Industry Federation data has been used, including as a basis for the split between direct combustion, direct process, and indirect electricity emissions. Where no greenhouse gas data is disclosed at the company level, industry data or average product information has been used to develop estimates.

Estimates have been checked for reasonableness using relevant academic studies and other reliable third party sources.

## Greenhouse Intensity of Earnings (Chart 3)

Greenhouse intensity of earnings values presented in this report have been developed using:

- For the construction materials sector, estimates of global direct and indirect electricity emissions. Mobile sources have been excluded where possible. Company estimates have been used where available.
- For other companies, greenhouse gas emission estimates reported by the company. Thus, estimates reflect the geographic and emissions source boundaries chosen by the company in preparation of its estimates. Wherever possible, total global direct and indirect electricity emissions have been used and mobile sources have been excluded. Estimates are the most recent year for which data was available at the time of drafting.
- EBITDA values as reported for the same period and the same geographic scope as greenhouse gas emissions estimates. In cases where earnings are not reported for the same scope as greenhouse gas emissions, EBITDA has been calculated or estimated from available information. For the steel producer example, an estimate of mid economic cycle earnings has been used.

## Australian Cement Industry Model

The cement industry model developed for this report includes:

- Production data;
- Greenhouse gas emission estimates ($tCO_2$-e) for each of the following categories – direct combustion, direct process, and indirect electricity; and
- Mid and low cycle revenue and earnings estimates.

Production data and emissions estimates have been sourced from the Cement Industry Federation.

As it is assumed that the carbon price liability is met by purchasing credits on market, the cost of carbon has been introduced into the model by multiplying the relevant emissions (direct combustion, direct process and/or indirect electricity) by the price per $tCO_2$-e. This additional cost flows through as a reduction in earnings and an impact on margins.

# References

[i] Includes energy and process emissions. Based on World Resources Institute (2005) *Navigating the Numbers: Greenhouse Gas Data and International Climate Policy*, available from http://www.wri.org/climate/pubs_description.cfm?pid=4093.

[ii] Calculated from data presented in Dept of Environment and Heritage (2006) *National Greenhouse Gas Inventory* 2004 available from http://www.greenhouse.gov.au/inventory/.

[iii] Ibid.

[iv] Percentage non-carbon dioxide greenhouse gas emissions (direct and energy); calculated from data retrieved from Australia's national greenhouse gas inventory for 2004, available from http://www.greenhouse.gov.au/inventory/.

[v] World Resources Institute and World Business Council for Sustainable Development (2004) *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (Revised Edition)* available from www.ghgprotocol.org.

[vi] Lawson B (1996) *Building Materials Energy and the Environment, Towards Ecologically Sustainable Development*, pp125-134.

[vii] Errors for process analysis data are ±10% and for input-output analysis approximately ±50% per Treloar et al (2001) 'Building Materials Selection: Greenhouse Strategies for Built Facilities', 19 *Facilities* 139, p140.

[viii] Full fuel cycle emission factors for end use from Australian Greenhouse Office (2005) *AGO Factors and Methods Workbook*, pp43-45 available from http://www.greenhouse.gov.au/workbook/pubs/workbook-2005.pdf.

[ix] Ibid.

[x] James Hardie (1999) *Towards Greener Sheets: An Environmental Profile of James Hardie Fibre-Cement Products*, p10.

[xi] Commonwealth Scientific and Industrial Research Organisation (2005) *Balancing Act: A Triple Bottom Line Analysis of the Australian Economy*, p150, available from http://www.cse.csiro.au/research/balancingact/.

[xii] Except where otherwise noted, all PER values are based on Baird G, A Alcorn and P Haslam (1997) *The Energy Embodied in Building Materials – updated New Zealand Coefficients and their Significance* available from http://www.ipenz.org.nz/ipenz/publications/transactions/Transactions97/civil/7baird.PDF.

[xiii] Cement Industry Federation (2005) *Cementing Our Future 2005-2030 – Technology Pathway for the Australian Cement Industry*, pp54-55, available from http://www.cement.org.au/publications/index.html. Note these values are per tonne of cement, rather than per tonne cementitious material.

[xiv] Calculated from data presented in the Cement Industry Federation (2005) *Annual Report to the Greenhouse Challenge Plus 2004-05*, available from http://www.cement.org.au/publications/index.html.

[xv] Ibid.

[xvi] This value is life cycle energy requirements, rather than just process energy, per Centre for Sustainable Technology (2003) *LCA for a Project Home*, p3, available from www.cbpi.com.au/resources/general/lca_fact_sheet.pdf.

[xvii] Ibid.

[xviii] Hanson has not been discussed further as this report is focussed on the S&P/ASX200.

[xix] Numerous publications have discussed this issue. For a thorough treatment, including estimation of the size of windfall profits, see IPA Energy (2005) *Implications of the EU Emissions Trading Scheme for the UK Power Generation Sector (Report to UK Department of Trade and Industry)* available from http://www.ipaenergy.co.uk/downloads&publications/FINAL%20Report%201867%2011-11-05.pdf.

[xx] There is no publicly available market data for the Greenhouse Friendly program. Approximate price information is based on personal communication from participants. For Chicago Climate Exchange carbon prices see www.chicagoclimatex.com.

[xxi] $10 has been chosen for simplicity, actual spot prices at the time of drafting were slightly higher than this figure. For current price information refer to the environmental products page on www.afma.com.au.

[xxii] Based on spot prices for trades on Powernext Carbon reported in *Tendances Carbone: The European Carbon Market Monthly Bulletin* (July 2006) available from http://www.caissedesdepots.fr/GB/publications/index.php.

[xxiii] Allen Consulting Group (2006) *Deep Cuts in Greenhouse Gas Emissions: Economic, Social and Environmental Impacts for Australia*, p30, available from www.acfonline.org.au/uploads/res_BLRT_allensreport.pdf.

# References

[xxiv] Australian Bureau of Agricultural and Resource Economics (2006) *Economic Impacts of Climate Change Policy: The Role of Technology and Economic Instruments*, p4, available from http://abarepublications.com/product.asp?prodid=13454.

[xxv] Pew Centre on Global Climate Change, *109th Congress Proposals* available from http://www.pewclimate.org/what_s_being_done/in_the_congress/108th.cfm.

[xxvi] For example, the Regional Greenhouse Gas Initiative (RGGI) established by the states of Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont, sets a cap on emissions from power plants commencing from 2009. For further information see http://www.pewclimate.org/what_s_being_done/in_the_states/rggi/index.cfm.

[xxvii] Prime Minister of Australia John Howard, 'Address to the Liberal Party Federal Council' (Speech delivered in Sydney, 3 June 2007) available from http://www.pm.gov.au/media/Speech/2007/Speech24350.cfm.

[xxviii] For CSR, only the building products division is included.

[xxix] Cement Industry Federation (2005) *Cementing Our Future 2005-2030 – Technology Pathway for the Australian Cement Industry*, p12, available from http://www.cement.org.au/publications/index.html.

[xxx] Organisation for Economic Cooperation and Development (2000) *Emission Baselines: Estimating the Unknown*, p51.

[xxxi] Centre for Sustainable Technology (2003) *LCA for a Project Home*, p3, available from www.cbpi.com.au/resources/general/lca_fact_sheet.pdf.

[xxxii] Cement Industry Federation (2005) *Cementing Our Future 2005-2030 – Technology Pathway for the Australian Cement Industry*, p5, available from http://www.cement.org.au/publications/index.html.

[xxxiii] Ibid.

[xxiv] Ibid, p8.

[xxxv] Cement Industry Federation (2005) *Annual Report to the Greenhouse Challenge Plus 2004-05*, p1, available from http://www.cement.org.au/publications/index.html.

[xxxvi] Boral Limited, *Sustainability Report 2005*, p27, available from http://www.boral.com.au/CommunityEnvironment/SustainableDevelopment.asp?site=CI&AUD=CommunityEnvironment.

[xxxvii] Rinker Group Limited (2006) *Results Presentation year ended 31 March 2006*, p49, available from www.rinker.com/downloads/YEM06%20Presentation%20for%20web%20FINAL.pdf.

[xxxviii] For further information see http://www.orer.gov.au/publications/mret-overview.html.

[xxxix] For further information see http://www.greenhouse.gov.au/challenge/.

[xl] For further information see http://www.energyefficiencyopportunities.gov.au/index.cfm.

[xli] Includes energy and process emissions. Based on World Resources Institute (2005) *Navigating the Numbers: Greenhouse Gas Data and International Climate Policy*, available from http://www.wri.org/climate/pubs_description.cfm?pid=4093.

[xlii] Australian Greenhouse Office, Embodied Energy Fact Sheet, available from http://www.greenhouse.gov.au/yourhome/technical/fs31.htm.

[xliii] See *Australian Conservation Foundation v Minister for Planning* [2004] VCAT 2029; Greenpeace 'Coal power proponent pulls out of legal battle' (Media Release, 8 September 2004) available from http://greenpeace.org.au/media/climate_details.php?site_id=12&news_id=1529; and *Wildlife Preservation Society of Queensland Proserpine/Whitsunday Branch Inc v Minister for the Environment & Heritage & Ors* [2006] FCA 736 (coal mines case).

# Resources

### Climate Science
Intergovernmental Panel on Climate Change http://www.ipcc.ch/

- *Fourth Assessment Report – Climate Change 2007*

Australian Greenhouse Office www.greenhouse.gov.au:

- *Stronger Evidence but New Challenges: Climate Change Science 2001-2005*

### Australia's Greenhouse Gas Emissions
National Greenhouse Gas Inventory http://www.greenhouse.gov.au/inventory/index.html

### Energy and Greenhouse Projections
National Greenhouse Gas Projections http://www.greenhouse.gov.au/projections/index.html

International Energy Agency www.iea.org:

- *World Energy Outlook www.worldenergyoutlook.org*

Australian Bureau of Agricultural and Resource Economics www.abare.gov.au:

- *Australian Energy: National and State Projections to 2029-2030*
- *Economic Impact of Climate Change Policy: the role of technology and economic instruments*

### Projected Impacts for Australia
Australian Greenhouse Office www.greenhouse.gov.au:

- *Climate Change – An Australian Guide to the Science and Potential Impacts*
- *Climate Change Scenarios for Initial Assessment of Risk in Accordance with Risk Management Guidance*

Commonwealth Scientific and Industrial Research Organisation www.csiro.au:

- *Climate Change Projections for Australia http://www.dar.csiro.au/impacts/future.html*

### International Agreements on Climate Change
United Nations Framework Convention on Climate Change and the Kyoto Protocol www.unfccc.int

Asia-Pacific Partnership on Clean Development (AP6) www.dfat.gov.au/environment/climate/ap6/

### Greenhouse Accounting
World Resources Institute http://www.wri.org/ and World Business Council for Sustainable Development www.wbcsd.org:

- *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard www.ghgprotocol.org*

### Carbon Trading
European Union Greenhouse Gas Emissions Trading Scheme http://ec.europa.eu/environment/climat/emission.htm

Chicago Climate Exchange www.chicagoclimatex.com

New South Wales Greenhouse Gas Abatement Scheme www.greenhousegas.nsw.gov.au

The World Bank Carbon Finance Unit www.carbonfinance.org:

- *State and Trends of the Carbon Market 2007*

International Emissions Trading Association www.ieta.org

Australian Financial Markets Association www.afma.com.au:

- *Market Data and Research – Environmental Products*

Australasian Emissions Trading Forum *www.aetf.net.au*

### Climate Change and Investment
Institutional Investors Group on Climate Change (UK) www.iigcc.org

Investor Network on Climate Risk www.incr.com

Investor Group on Climate Change (Australia / New Zealand) www.igcc.org.au

The Carbon Disclosure Project www.cdproject.net

The Carbon Trust www.carbontrust.co.uk:

### Valuing Climate Change Risk
The Carbon Trust www.carbontrust.co.uk:

- *Climate Change and Shareholder Value*
- *A Climate for Change – A trustee's guide to understanding and addressing climate risk*
- *Brand Value at Risk from Climate Change*
- *Investor Guide to Climate Change*

United Nations Environment Programme Finance Initiative www.unepfi.org:

- *Show Me The Money: Linking Environmental, Social and Governance Issues to Company Value*
- *The Materiality of Social, Environmental and Corporate Governance Issues to Equity Pricing*

Enhanced Analytics Initiative www.enhancedanalytics.com

Ceres www.ceres.org and World Resources Institute www.wri.org:

- *Framing Climate Change Risk in Portfolio Management*

Total Environment Centre www.tec.org.au (authors AMP Capital Investors and Baker & McKenzie):

- *Climate Change and Company Value: a Guide for Company Analysts*

### Climate Change and Construction Materials
World Business Council for Sustainable Development www.wbcsd.org:

- *Cement Sustainability Initiative*
- *The Cement $CO_2$ Protocol: $CO_2$ Accounting and Reporting Standard for the Cement Industry*

Australian Cement Industry Federation www.cement.org.au:

- *Cementing Our Future 2005-2030 – Technology Pathway for the Australian Cement Industry*
- *Annual Reports to Greenhouse Challenge*

## Investor Group on Climate Change (IGCC)


The IGCC represents institutional investors, with total funds under management of over $375 billion, and others in the investment community interested in the impact of climate change on investments. The aim of the IGCC is to ensure that the risks and opportunities associated with climate change are incorporated into investment decisions for the ultimate benefit of individual investors. One of the key ways in which IGCC can work toward achieving this aim is through involvement in research projects such as this, to help the investment community better understand and assess climate change impacts.

## Monash Sustainability Enterprises (MSE)


MSE is a multi-disciplinary research centre which specialises in the development of robust methodologies to analyse linkages between corporate social and environmental management and financial drivers. MSE has pioneered the practical application of environmental and social rating and analysis in Australian financial markets. Through its relationship with Regnan governance research and engagement services, MSE is the leading ESG research provider to many of Australia's largest institutional investors.

## Merrill Lynch


Merrill Lynch is one of the world's leading wealth management, capital markets and advisory companies with offices in 37 countries and territories and total client assets of approximately $1.7 trillion. As an investment bank, it is a leading global trader and underwriter of securities and derivatives across a broad range of asset classes and serves as a strategic advisor to corporations, governments, institutions and individuals worldwide. Merrill Lynch owns approximately half of BlackRock, one of the world's largest publicly traded investment management companies with more than $1 trillion in assets under management.

## Australian Government


The Australian Government Department of the Environment and Water Resources (formerly the Departmenwt of the Environment and Heritage) develops and implements national policy, programs and legislation to protect and conserve Australia's natural environment and cultural heritage.

Other reports in the series are available at www.igcc.org.au